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Preliminary Feasibility Study of Resource Recovery for Greensboro, High Point, and Winston-Salem, North Carolina (Technical Report - Phase I)

CSI Resource Systems, Inc.
Boston, MA

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A TECHNICAL ASSISTANCE PROGRAM REPORT

PRELIMINARY FEASIBILITY STUDY OF RESOURCE RECOVERY FOR GREENSBORO, HIGH POINT AND WINSTON-SALEM, NORTH CAROLINA

TECHNICAL REPORT

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RESOURCE RECOVERY AND CONSERVATION PANELS

SEC. 2003. The Administrator shall provide teams of personnel, including Federal, State, and local employees or contractors (hereinafter referred to as "Resource Conservation and Recovery Panels") to provide States and local governments upon request with technical assistance on solid waste management, resource recovery, and resource conservation. Such teams shall include technical, marketing, financial, and institutional specialists, and the services of such teams shall be provided without charge to States or local governments.

This report has been reviewed by the Project Officer, EPA, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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The objective of this study was to determine, on a preliminary basis, the economic and technical feasibility of adopting resource recovery as a solid waste management option for the cities of Greensboro, High Point, and Winston Salem, North Carolina. This study entails a market survey of some 50 industrial and institutional consumers. Energy requirements of prospective buyers were matched with demonstrated technologies which resulted in seven resource recovery options. Of the seven, four were determined to be technically feasible. Recommended systems are modular combustion and/or waterwall combustion, each producing the necessary steam for their customers. In size, these systems have a capacity to handle from 90 TD_6 to 625 TPD_7. This report is one part of three volumes addressing resource recovery in this triad region of North Carolina.

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PRELIMINARY FEASIBILITY STUDY
OF
RESOURCE RECOVERY FOR
GREENSBORO, HIGH POINT AND WINSTON-SALEM, NORTH CAROLINA

TECHNICAL REPORT

PREPARED FOR

OFFICE OF SOLID WASTE MANAGEMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV, ATLANTA, GEORGIA

BY

CSI RESOURCE SYSTEMS, INC.
BOSTON, MASSACHUSETTS

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CHAPTER 1

PROJECT SYNOPSIS

The objective of this study was to determine, on a preliminary basis, the economic and technical feasibility of adopting resource recovery as a solid waste management option for the cities of Greensboro, High Point, and Winston-Salem, North Carolina thereby converting the region's abundant solid waste resources into a useable energy form.

The Triad Region of North Carolina consisting of the Cities of Greensboro, High Point and Winston-Salem annually produces nearly 570,000 tons of municipal solid waste (MSW). Typical Higher Heating Value (HHV) estimates of 4500 Btu per pound of MSW suggest that the energy value of each ton of MSW recovered is equivalent to 1.4 barrels of oil, and thus the region currently discards in the form of MSW the energy equivalent of nearly 800,000 barrels of oil per year.

Recent OPEC production cutbacks and pricing decisions which lead to significant shortages and dramatic price increases in various petroleum products, have forced economists and energy experts to question both the cost and future availability of key petroleum based products. These cost and supply uncertainties give additional credance to the concept of converting the region's substantial solid waste resources to a useable energy form.

Since 1974, High Point has shredded the processible portions of the municipal solid waste generated by its residential, commercial and industrial sectors and delivered to the City-owned and operated landfill to effect collection/disposal efficiencies and to extend that site's remaining life. Greensboro, the Triad Region's largest city and major waste generator, is in the process of installing a shredder complex at its disposal site also with the objective of achieving collection/disposal efficiencies and extending the remaining life of its landfill. Because Duke Power Company was constructing a new coal-fired generating facility at Belews Creek,

approximately 30 miles from Greensboro, the utility was approached to determine its interest in exploring the concept of utilizing a fuel processed from the shredded solid waste available from High Point, Greensboro, and possibly Winston-Salem. Under this concept, about 1000 tons per day (TPD_6) of the region's estimated daily tonnage of 1800 would be converted to a refuse-derived fuel (RDF) for use as a supplemental fuel in the utility's coal-fired boilers.

In evaluating the feasibility of resource recovery for the region, other resource recovery options, in addition to the RDF concept previously envisioned, were also considered. To that end, a market survey was performed to determine the energy practices and requirements of approximately 50 of the region's largest industrial and institutional energy consumers.

From the extensive energy market survey there emerged six prospective energy buyers whose location, energy practices and requirements, and preliminary interest indicated that they could be considered further as potential customers for the energy or fuel produced by a resource recovery system accepting waste from one or more of the region's major cities. A match of the energy requirements of the prospective buyers with one or more of four demonstrated technologies resulted in seven resource recovery options which initially appeared to be technically feasible. Preliminary economics were then developed for each of these apparently feasible options to determine which, if any, would be cost-competitive with the projected costs of continued landfill disposal.

Of the seven options, four were evaluated as both technically feasible and, to varying degrees, economically viable. One resource recovery option appears highly promising, another two appear promising, and one has potential, if certain siting impediments can be overcome. Another three were dismissed from further consideration due to both technical uncertainties and unattractive economics.

It must be emphasized that the initial interest expressed by the various industrial concerns in the concept of purchasing the energy product of a resource recovery facility does not indicate

that any of these private sector firms will either enter into negotiations at this time or ultimately commit to purchase. As a consequence of this reality, the specific technology/market match which constitutes the various resource recovery system options were evaluated to demonstrate that resource recovery opportunities exist and to quantify on a preliminary basis the resultant economics of the apparent set of options.

The seven resource recovery options which follow were classified into four categories: highly promising, promising, having potential, and unlikely. These resource recovery options, their proposed sources of waste, and their projected 1983 net disposal costs follow:

Highly Promising

- Winston-Salem 250 TPD_6 Modular Combustion System -
  Producing Steam for sale to Hanes
  Accepting a portion of the available and processible 520 TPD_6 of solid waste generated by Winston-Salem.

  NET DISPOSAL COST: $4.60/ton

Promising

- Greensboro 625 TPD_7 Waterwall Combustion System -
  Producing Steam for sale to Lorillard and A&T University
  Accepting all of the available and processible solid waste generated by Greensboro.

  NET DISPOSAL COST: $7.60/ton

Potential

- High Point 90 TPD_6 Modular Combustion System -
  Producing Steam for sale to J.P. Stevens
  Accepting a portion of the available and processible 200 TPD_6 of solid waste generated by High Point.

  NET DISPOSAL COST: $4.10/ton

- Greensboro 470 TPD_6 Waterwall Combustion System -
  Producing Steam for sale to Cone
  Accepting a portion of the available and processible 730 TPD_6 of solid waste generated by Greensboro.

  NET DISPOSAL COST: $12.50/ton

Unlikely

- Decentralized 1015 RDF System -
  Producing RDF for sale to Belews Creek
  Accepting all of the available and processible
  1015 TPD_6 of solid waste generated by Greensboro,
  High Point, and Winston-Salem.

  NET DISPOSAL COST: $10.10/ton

- Greensboro 625 TPD_7 Waterwall Combustion System -
  Producing Steam and Electricity for sale to Cone
  Accepting all the available and processible solid
  waste generated by Greensboro.

  NET DISPOSAL COST: $10.20/ton

- Greensboro 625 TPD_7 Waterwall Combustion System -
  Producing Steam and Electricity for sale to Cone.
  Accepting all the available and processible solid
  waste generated by Greensboro.

  NET DISPOSAL COST: $14.60/ton

The projected 1983 net disposal cost for the respective resource recovery options ranged from a low of approximately $4 per ton to nearly $15 per ton. However, other dimensions were also considered in addition to projected net disposal cost before determining which of these resource recovery options are appropriate for one or more of the Triad cities. These considerations include the capacity of the respective systems to process the available waste, the varying state of technology demonstrated for each resource recovery option, and technical, institutional, and legal constraints to the implementation of a specific project.

Principle Findings

Principal findings from the preliminary technical and economic evaluation of the feasibility of solid waste resource recovery for one or more of the Triad cities are:

- A regional Refuse Derived Fuel (RDF) System converting the solid waste from two or three of the region's major cities into RDF for use at Belews Creek is not a feasible resource recovery option for the Triad Area because of significant uncertainties in the pricing of

the RDF product, wide variances in costs between the participating communities, the necessary consumption of expensive and increasingly less available diesel fuel for transporting the RDF and substantial quantities of process rejects requiring landfill disposal.

- A Winston-Salem Modular Combustion System producing steam for sale to Hanes seems the most promising resource recovery option available. This option results in 1983 estimated net disposal costs of $4.60 per ton and presents an opportunity for Winston-Salem to consolidate its present disposal facilities and thereby achieve additional savings.

- Two Greensboro Resource Recovery Systems appear to be technically feasible. Each is based on a waterwall combustion or dedicated boiler concept. The first produces steam for sale to Lorillard and A & T University, and results in reasonably competitive projected net disposal costs of $7.60 per ton. The second produces steam for sale to Cone Industries and projects a higher net disposal cost of $12.50 per ton. While the first appears more promising, the second option has potential, particularly if projected disposal costs and fuel costs continue to rise. As a consequence, both options should be evaluated further.

- A High Point Modular Combustion System producing steam for sale to the West Avenue facility of J.P. Stevens is evaluated as having potential. The projected 1983 net disposal costs of $4.10 per ton are very competitive with the option of continued landfilling. However, possible siting limitations could make the implementation of this project difficult.

Other Technical, Economic and Institutional Findings and Considerations

In addition to the above principal findings there are a number of technical, economic and institutional findings and considerations which became apparent in the course of this study. Chief among these include:

- Irrespective of resource recovery option implemented, there will remain a significant portion of the solid waste stream as an unprocessible or residual necessitating ultimate landfilling. This percentage, on a tonnage basis, may run as high as 44 percent of solid waste input for the RDF option, to a low of approximately 36 percent for the waterwall combustion option.

- The lead times for all resource recovery options are significant, with 1983 as the earliest possible implementation date for the waterwall combustion or dedicated boiler systems and late 1981 as the earliest possible date for a modular combustion system

- While each of the three cities now enjoys modest landfill disposal costs reflecting efficient current operation, future disposal costs are expected to increase significantly due to inflationary factors and the required operation and capital improvements mandated by RCRA.

- Since this study began, the various industrial concerns which expressed preliminary interest in the concept of utilizing the energy product of a resource recovery system have experienced dramatic increases in the price of their fuel oil. Thus, revenue projections for the various resource recovery options must be updated to reflect more accurately these trends upon the resultant system economics.

- The Triad Region enjoys modest electricity costs, due to the extensive use of low-cost coal and nuclear fuels, making the production of electricity a less attractive resource recovery option.

- While a preliminary market study indicated that there were six prospective customers interested in the concept of purchasing energy from a resource recovery project, this interest was both preliminary and cautious. For that reason, the level of commitment must be established for each of the prospective customers to ensure that in fact there will be an energy buyer if a project proceeds further.

- Until recently, industry viewed resource recovery primarily as a lower quality, less reliable energy supply option, and expected the price of the energy product to reflect this opinion. This perspective is just beginning to change, with industrial concerns recognizing that resource recovery can afford varying degrees of energy self sufficiency for a system's customer.

- Solid waste officials and citizenry should begin to view the nearly 1550 TPD_7 of solid waste from the Triad region as an abundant potential energy resource.

- Resource recovery could be utilized as an industrial development catalyst, attracting new industry to the region, with the promise of competitively priced fuel and secure supplies of energy.

CHAPTER 2

BACKGROUND AND SOLID WASTE PRACTICES

Background

The cities of Greensboro and High Point in Guilford County, and Winston-Salem in Forsyth County, and several smaller surrounding communities constitute the Triad Region of North Carolina. The three cities had an estimated 1975 combined population of 365,000 and project a 1980 combined population of 386,000.* In 1978 the population and economic activity of Greensboro, High Point, and Winston-Salem generated nearly 570,000 tons of residential, commercial and industrial solid waste, or about 1550 tons per day on a 7-day-week basis (TPD_7). It should be noted that this tonnage translates to a daily per capita waste generation of 8.6 pounds, a figure substantially higher than the estimated national average. This higher figure is attributed in large part to industrial sector activity--in particular, the various textile and tobacco processing concerns which generate substantial quantities of solid waste materials.

All waste generated within the two counties is disposed of in one of six landfills, under the terms of an intergovernmental agreement among local governments and their respective counties. Greensboro owns and operates one landfill; High Point owns and operates one as well; three landfills are owned and operated by Winston-Salem. The City of Kernersville also owns and operates a landfill.

The Piedmont Triad Council of Governments has projected a compound annual population growth factor of approximately 1 percent for the Forsyth County area over the period 1970 through 1990; the growth factor over the same period for Guilford County is projected 0.9 percent. For the sake of analysis, no corresponding growth in per capita solid waste generation has been assumed. A zero growth factor in the per capita solid waste generation has been projected largely for three reasons. First, considerable efforts by the industrial sector will be made in utilizing internally generated waste as a potential energy

*Piedmont Triad Council of Governments, Region G, of North Carolina, 1978 Statistical Summary.

source. As an example, the Reynolds Tobacco Company has recently contracted to have installed a waste boiler capable of converting up to 120 TPD of internally generated waste into steam. Second, the prospect of Federal beverage container legislation suggests a significant future reduction in beverage container-related waste. Third, is the belief that industry will respond to projected dramatic increases in energy costs by a reduction in redundant and energy-intensive packaging practices. The cumulative effect of these three factors will mitigate the future solid waste generation of the three major cities in the Triad Region.

Solid Waste Practices

The City of High Point has shredded the processible residential, commercial, and portions of industrial solid waste materials to a nominal 4 inch particle size prior to landfilling since 1974. The City's objectives in shredding the MSW is to extend the remaining life of its disposal facility and to realize collection/disposal efficiencies. Estimates are that approximately 20 to 25 percent of the industrial waste received at High Point is not shredded, as it constitutes materials such as scrap bolts of cloth, baling wire, or other materials which could cause downtime or injure the shredder equipment. Prior to shredding, waste delivered to the landfill by commercial truck or refuse packer is weighed, while waste delivered by automobile or pickup truck is estimated. The City of High Point disposed of approximately 78,070 tons of solid waste during the period July 1, 1977 through June 30, 1978.

The City of Greensboro disposed of an estimated 284,740 tons of solid waste at the White Street landfill during the period April 1, 1977 through March 31, 1978 (Refer to Table 1). To extend the remaining life of its city-owned and -operated landfill and to achieve collection/disposal efficiencies, Greensboro is installing a shredding facility which will pulverize the solid waste prior to landfilling. A scale to weigh the waste delivered by incoming vehicles will also be installed. It is expected that the scale and shredding complex will be operational in October, 1979.

TABLE 1

1978

WASTE GENERATION FIGURES

	Total Annual Waste	Total Daily Waste	Processible* Daily Waste
GREENSBORO: (April 77 - March 78)	284,710		
TPD_7:		782	624
TPD_6:		913	730
TPD_5:		1,095	876
HIGH POINT: (July 77 - June 78)	78,070		
TPD_7:		214	172
TPD_6:		250	200
TPD_5:		300	240
WINSTON-SALEM: (January 78 - December 78)	202,960		
TPD_7:		558	441
TPD_6:		651	520
TPD_5:		781	624

*Processible component estimated at 80 percent of available solid waste.

Winston-Salem currently weighs all of the residential, commercial, and industrial waste which is delivered to two of its three landfills. The third landfill is reserved exclusively for use by city collection vehicles which are not weighed. However, the is able to reasonably estimate the tonnages delivered by its collection vehicles. At present, Winston-Salem does not shred its waste and has no plans to do so in the future. Records kept by the Department of Public Works at Winston-Salem indicated that 1978 waste generation was approximately 202,960 tons per year. The basis of these recorded tonnage figures was the period January 1, 1978 through December 31, 1979.

Based on extensive records kept by the various solid waste departments of the respective communities, it appears that each of these communities currently enjoys modest landfill disposal costs reflective of efficient operations. As an example, the 1979 estimated cost of disposal for Greensboro was approximately $1.80 per ton; for High Point, about $5.50 per ton; and for Winston-Salem, just under $3.00 per ton.

Greensboro solid waste officials estimate that the City's cost of disposal will increase to a range of $5.00 to $5.50 per ton when the shredder system first becomes operational. These projections fully reflect equipment amortization, maintenance, utilities, labor and other expenses attendant with the new shredder/disposal complex. In part, the increased cost of disposal resulting from the added processing will be offset by labor and equipment maintenance savings realized within the City's collection activities. Because the refuse collection vehicles will be able to discharge MSW directly at the site of the shredding facility and thus no longer be required to proceed cautiously to the working face of the landfill, wait for clearance before dumping, and then slowly exit from the landfill (particularly in times of inclement weather and peak delivery periods), the packer trucks will utilize less fuel and collection personnel will spend less non-productive time waiting to deliver solid wastes. Moreover, because the collection vehicles will no longer have to transverse exceptionally

rough terrain typical of most operating landfills, it is likely that noticeable maintenance savings will be achieved as damage to tires and axles are greatly reduced.

To establish the economic feasibility of the various resource recovery alternatives, it was necessary to project future disposal costs as a reference against which the cost competitiveness of the various resource recovery options could be evaluated. For comparative purposes, 1983 landfill disposal costs were estimated at $8.50 per ton for Greensboro; $12.00 per ton for High Point; and $6.50 per ton for Winston-Salem.

In developing the 1983 disposal cost estimates, two assumptions were made. First it was assumed that the participating communities would meet the U.S. Environmental Protection Agency draft guidelines on landfill design and operation which may mandate extensive modifications to existing landfills, including: gas migration control and monitoring, leachate control and monitoring, surface runoff control systems, as well as increased daily and final coverage factors. These guidelines are expected to be promulgated formally by the end of 1979. According to the draft Environmental Impact Statement on the proposed guidelines for the landfill disposal of solid waste, the immediate impact of these changes will be to increase the per-ton cost of disposal of a typical 300 TPD model landfill by approximately $2 per ton, nearly 50 percent above current estimated disposal costs for a facility of this size.

In light of this estimate of the cost impacts of meeting these new landfill design and operational standards, it is reasonable to project that the initial cost impact upon Greensboro, High Point and Winston-Salem landfill operations could be in the range of $.50, $1.00 and $2.00 per ton respectively. Second, it is assumed that aggregate landfill disposal costs will escalate 10 percent per year (compound basis) reflecting primarily the impacts of inflation upon fuel and labor components.

Approximately 570,000 tons of solid waste are generated annually by the three major cities in the Triad Region. However, a

portion of this material is unsuitable for processing into fuel or energy and must be directly landfilled without shredding. The unprocessible portion includes oversized, bulky products, construction and demolition waste, branches, limbs, and other materials which would injure the shredder. For the purposes of this analysis, it was assumed that the 20-percent unprocessible component observed at High Point is representative of all three communities.

Under the RDF scenario, where the processible portions of the solid waste would be shredded at High Point, Greensboro and Winston-Salem and refined into a fuel suitable for use in the Belews Creek coal-fired facility, considerable portions of this processible waste would become a process reject. For the sake of analysis, it is assumed that 70 percent of the processible portion would ultimately be processed into RDF. The net result is that 56 percent of the waste available would ultimately be processed into a refuse-derived fuel. The remaining 44 percent (by weight) representing oversized materials and process rejects would require landfill disposal.

Under the various waterwall combustion options, it is assumed that approximately 80 percent of the available waste would be appropriate for combustion. After combustion, a residue approximating 8 percent by volume and 20 percent by weight of the combustible component will remain, in addition to the unprocessible component.

Thus, for those waterwall combustion systems sized to accept all of a community's available solid waste, approximately 36 percent by weight of the material received will be recovered in the form of unprocessibles and residuals and will require landfill disposal.

The quantity of waste requiring landfill disposal under the modular combustion technology will be comprised of tonnages in excess of resource recovery system capacity, as well as residuals from disposal (20 percent of the combusted fraction).

Irrespective of the resource recovery alternative utilized, it is apparent that a significant portion of the waste supply will be unsuitable for processing into energy, will become a process reject, or will become a residual after combustion and thus require ultimate disposal by landfill.

CHAPTER 3

POTENTIAL ENERGY MARKETS

The coal-fired Belews Creek facility of Duke Power was identified as one potential customer for a refuse-derived fuel produced from the solid waste generated by the cities of Greensboro, High Point and Winston-Salem. Other feasible resource recovery options were also to be considered. To that end an energy market survey was performed, the purpose of which was to determine if other potential customers for the fuel or energy derived from a resource recovery system serving one or more of the Triad cities existed.

The names and contact information for nearly fifty of the area's largest industrial and manufacturing concerns, commercial establishments, hospitals, and colleges and universities (obtained from records of the tax, solid waste or industrial development departments of the respective communities) served as a starting point. Several apparent energy-intensive concerns which were not included in the initial listing were identified as the study proceeded. Each concern was viewed as a potential energy customer and was contacted by phone to determine its interest in the concept of purchasing fuel or energy produced from a resource recovery system. After initial interest was established, information relative to current and projected energy requirements and practices, including types and quantities of fuel(s) used, and seasonal and daily variability in demand, was solicited as well as a description of physical plant and power-generating facilities. Attempts were also made to ascertain whether potential contiguous sites for the location of a resource recovery system might be available.

Because of time constraints, not all of the concerns for which contact information was provided were contacted. Where a number of concerns were identified as belonging to the same industry, and thus were found to have similar energy practices and requirements, the company specific information obtained from several was considered

representative of the remaining. As an example, four of the sixteen firms in the wood products industry were contacted. Information acquired from the contacted wood products concerns indicated that energy usage in this industry is largely electrical and that abundant internally generated wood wastes are typically burned in small waste boilers to meet space heating requirements during the winter months.

A number of establishments contacted by phone indicated that they were not interested: many of them because they already utilized alternative fuels (i.e., wood wastes generated in the manufacturing process) or waste heat from their processes, or because they had only a limited seasonal use for steam (primarily during the heating season). Other establishements contacted, while expressing some interest in the concept, indicated that their average hourly steam usage was low (less than 10,000 pounds per hour--the equivalent of about 50 TPD of solid waste), that they operated on one or two shifts per day, or that they felt finding a conveniently located site for an energy recovery facility would be extremely difficult because of the residential nature of the contiguous area or the absence of any appropriate site.

Thirteen of the concerns contacted by phone expressed a preliminary interest in the concept and also appeared to offer, by virtue of their current or projected energy practices and requirements, the potential to be supplied energy or fuel from the various technically feasible resource recovery options.

The purpose of the subsequent follow-up interviews was to assess the degree of interest in considering the purchase of recovered energy and to determine among other things the type of fuel which would be displaced, the current price for fuel, and the estimated cost of producing steam for internal consumption; type, and age of boiler and fuel storage systems in use and plans for replacement or expansion, average hourly steam consumption, seasonal patterns in steam consumption, steam pressure and temerature requirements, numbers of shifts which facility operated, and number of days per

week and annually which facility operated, and other special considerations or factors that needed to be recognized.

Of the approximately thirty establishments from which in-depth phone or personal interviews were obtained, only five appeared to warrant consideration for further investigation. These five establishments were judged to meet the following considerations acceptably:

- Each concern expressed interest in the concept of utilizing energy recovered from solid waste. It should be noted that in no case was enthusiastic interest expressed. However, since the contacts were made prior to the recent dramatic oil price increases imposed by OPEC, the degree of interest may have significantly increased in the interim.

- At each facility low pressure steam--an energy form which can be readily produced from various resource recovery technical options--is used for processing and/or for year-round heating and cooling needs, average hourly steam loads are generally high, seasonal variations in steam usage appear to be within an acceptable range, and no unusual pressure or temperature requirements exist.

- The respective plants operate on a three-shift, 5-to-6-day week, indicating potential for a high capacity utilization factor.

- At each facility oil would be the fuel displaced, and the cost of oil at the time of the survey was about $2.50 per thousand pounds of steam. (The fuel cost of $2.50 per thousand pounds was judged to be the minimum cost acceptable for viable project economics, based upon economic analysis for recovery projects elsewhere in the country.)

- For each prospective energy customer potentially available vacant sites exist which appear to be of adequate size and to be located within a reasonable steam transport distance of the respective establishments.

- Each organization has been located in the Triad area for a number of years and seems to be in reasonably good financial health to justify consideration as a long-term energy buyer.

In consideration of the above parameters, five concerns (in addition to the previously cited Belews Creek facility of Duke Power) emerged from the energy market study as potential customers of energy or fuel form a resource recovery system serving one or more of the Triad cities. By city these follow:

Greensboro:

- Cone Industries
- Lorillard and/or A & T University

High Point:

- J. P. Stevens (West Avenue facility)

Winston-Salem:

- Hanes Corporation (Route 52, Weeks Plant)

CHAPTER 4

TECHNICAL APPROACH AND SYSTEM DEFINITION

Technical Approach

In efforts to match the quantity and characteristics of the waste available from the respective communities with the requirements of the previously identified prospective energy customers, consideration was given to four generic resource recovery technologies. Each of the following technologies has been demonstrated at commercial scale or is in the process of start-up and thus has reasonably established operating parameters:

- Refuse derived system producing RDF for sale to Duke Power or other solid fuel users
- Massburn waterwall system with the production of steam, or steam and electricity (cogeneration)
- Dedicated boiler system wherein coarsely shredded solid waste is fired in a specially designed solid fuel boiler to produce steam
- Modular combustion system with the production of low pressure steam

The first technology considered was the production of RDF for sale as a supplemental fuel to the Belews Creek facility of Duke Power or one or more proximate industrial or institutional solid fuel users. Examples of this technology include resource recovery systems located at Milwaukee, Wisconsin and Ames, Iowa.

The second resource recovery technological approach is a mass-burning waterwall combustion concept. Two options were considered under this technology: the production of steam and the production of both steam and electricity (cogeneration). The production of electricity alone was not considered because of institutional and legal difficulties in retailing electricity and the fact that such a system would be selling electricity priced against abundant and low priced electricity produced by Duke Power. Waterwall combustion systems producing steam are operating in Nashville, Tennessee; Saugus, Massachusetts; and Norfolk, Virginia.

The third technical option considered was a dedicated boiler resource recovery system. Under this concept solid waste is pulverized at the existing shredding facilities to a nominal four inch particle size. Before shredding, oversize bulky materials (OBM) and other unprocessibles are extracted and after shredding the pulverized waste is run under a magnet and magnetic materials are recovered for sale to scrap markets. The coarsely shredded solid waste is then fired as the primary fuel in a specially designed boiler. Steam is produced for sale to an energy customer. Examples of this technical approach include the Hamilton, Ontario and Akron, Ohio (in start-up phase) resource recovery systems.

The fourth resource recovery technology considered is a small scale modular combustion system capable of accepting from less than 100 TPD_5 up to 250 TPD_7 and producing for sale from 10,000 to 50,000 pounds of low pressure steam per hour. Examples of this technology include systems at North Little Rock, Arkansas and Salem, Virginia.

Matching the quantity and types of waste available from the respective cities and the energy requirements of the potential industrial customers with appropriate (and existing) technologies resulted in seven feasible resource recovery options. They follow:

- 1015 TPD_6 decentralized RDF system; RDF processing facilities and transfer stations at High Point, Greensboro, and Winston-Salem with sale of RDF to Duke Power at Belews Creek.
- 625 TPD_7 Greensboro Waterwall Combustion System or Dedicated Boiler System producing steam for sale to Lorillard and A & T University
- 625 TPD_7 Greensboro Waterwall Combustion System or Dedicated Boiler System producing steam and electricity for sale to Lorillard
- 470 TPD_7 Greensboro Waterwall Combustion System or Dedicated Boiler System producing steam for sale to Cone
- 625 TPD_7 Greensboro Waterwall Combustion System or Dedicated Boiler System producing steam and electricity for sale to Cone

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- 90 TPD_6 High Point Modular Combustion System producing steam for sale to J.P. Stevens (West Avenue Facility)

- 250 TPD_6 Winston-Salem Modular Combustion System producing steam for sale to Hanes (Route 52 Weeks Facility)

In-depth engineering estimates of the capital and operations, maintenance and repair expenses (O,M&R) of waterwall combustion and dedicated boiler systems have recently been performed in resource recovery feasibility studies for the cities of New York and St. Louis. The results of these detailed technical and economic evaluations indicated that the capital and O, M&R costs of comparably sized waterwall combustion and dedicated boiler technologies are likely to be competitive with one another. For the purpose of this analysis the two technologies are interchangeable in terms of both technology and resultant economics.

The ultimate choice between the waterwall combustion and dedicated boiler technologies can only be made after detailed customer and site specific information is acquired and evaluated to ensure that an optimal system is ultimately implemented.

Because of the region's low costs for electricity (produced from competitively priced coal and nuclear fuels) and due to the substantial additional capital costs for equipment to convert steam to electricity, the production of electricity as a primary product was not considered as an economically viable option.

Optimizing the RDF System Option

Because the capital intensive process of shredding is the first step in the production of refuse-derived fuel (RDF) and solid waste pulverizing equipment is in place at High Point and under construction at Greensboro and due to the fact that Duke Power's Belews Creek coal-fired facility is located nearby, the concept of producing RDF for sale as a supplemental fuel warranted further analysis. To determine the economic feasibility and technical viability of producing RDF, four RDF system approaches were considered. The first

System Sizing and Disposal Efficiency

. The sizing of each resource recovery option was largely an optimizing type of problem, giving consideration to the energy requirements of the potential customer, as well as available waste supply and consequent disposal problems of the participating community. As a result, although the technologies appear similar in several cases, there are discrepancies in the size of the systems proposed, reflecting differences in the energy requirements of the prospective energy purchaser and availability of solid waste.

Each resource recovery option has a varying degree of effectiveness in disposing of the available waste. As an example, the refuse-derived fuel option accepting waste from all three major communities ultimately disposes of approximately 56 percent (by weight) of the waste generated by each of the communities with the remaining 44 percent comprising oversized bulky materials (OBM) and process rejects requiring landfill disposal. The waterwall combustion and modular combustion resource recovery systems both require landfill disposal. The OBM and combustion residuals from the 625 TPD_7 systems; and OBM, combustion residuals and bypassed tonnages in excess of capacity for the smaller systems all require landfilling.

CHAPTER 5

ECONOMIC, INSTITUTIONAL AND TECHNICAL ASSESSMENT OF RESOURCE RECOVERY OPTIONS

Introduction

Economic, institutional and technical assessments were performed for each of the seven resource recovery options which were considered. This chapter presents the general features of each technical option, projects the resultant 1983 first-order economics, and describes the advantages and disadvantages including economic, institutional and technical considerations of each resource recovery alternative relative to the solid waste management practices of continued shredding/landfilling or direct landfilling.

After the economic, institutional and technical aspects of each resource recovery option have been evaluated, the consultant's recommendation as to what action the respective communities should take is given.

The underlying economic and technical assumptions used to evaluate each technical option are contained in the Economic and Technical Assumptions Section of the Appendices.

Table 2 on the following page compares the 1983 projected net disposal costs of the resource recovery options described in this chapter. Table 12 at the end of this chapter presents in summary form the advantages and disadvantages of each resource recovery system.

Table 2

SUMMARY OF TRIAD AREA RESOURCE RECOVERY OPTIONS

SYSTEM OPTION	PER TON DISPOSAL COST
1015 TPD_6 Decentralized RDF System:	$10.70*
Greensboro	$ 8.00
High Point	19.00
Winston-Salem	11.20
Greensboro:	
625 TPD_7 Waterwall Combustion or Dedicated Boiler System (Steam to Lorillard and A&T University)	$ 7.60
625 TPD_7 Waterwall Combustion or Dedicated Boiler System (Electricity and Steam to Lorillard)	10.20
470 TPD_6 Waterwall Combustion or Dedicated Boiler System (Steam to Cone)	12.50
625 TPD_7 Waterwall Combustion or Dedicated Boiler System (Electricity and Steam to Cone)	14.60
High Point:	
90 TPD_6 Modular Combustion System (Steam to J. P. Stevens)	4.10
Winston-Salem:	
250 TPD_5 Modular Combustion System (Steam to Hanes)	4.60

*Weighted average basis

DECENTRALIZED 1015 TPD_6 RDF SYSTEM

The decentralized 1015 TPD_6 RDF system consists of four elements: the existing High Point shredding/transfer facility with subsequent modifications; the proposed Greensboro shredder/transfer facility with modifications; the construction of a Winston-Salem shredding/transfer station complex; and modifications to the Belews Creek coal-fired boiler facility of Duke Power.

The modifications to the High Point and Greensboro shredder/transfer complexes includes the addition of a magnetic separator, trommel, air classifying equipment, disc screen, and secondary shredder to effect one inch particle size. For High Point and Greensboro this equipment is in addition to the existing tipping pad and primary shredder which reduces the solid waste input to four inch particle size. For Winston-Salem it is necessary to construct an entirely new shredding/transfer station system. The shredding elements include tip pad, building complex and primary shredder as well as magnetic separator, tommel, air classifier, disc screen and secondary shredder. The transfer station consists primarily of a building, receiving and storage area, compacting equipment, and transfer trailers and tractors.

High Point currently has two tractor/trailer sets in operation and Greensboro is expected to have four tractor/trailer sets in operation by October, 1979. Thus, the transfer equipment requirements and resultant capital costs for these two communities under the decentralized RDF resource recovery option are commensurately reduced. To meet the requirements of delivering RDF to Belews Creek it is envisioned that High Point needs one additional compactor and tractor/trailer set while Greensboro would need another five tractor/trailer sets.

Modifications at Belews Creek include facilities for the receiving of RDF, material handling equipment, storage and conveying equipment and modifications to the boiler itself.

Economics

Estimated 1983 capital costs to convert the envisioned Greensboro and existing High Point Solid Waste shredding/transfer complexes into RDF processing systems are $5,595,000 and $2,590,000, respectively. Capital costs (1983) for constructing an RDF system at Winston-Salem approximates $6,384,000. The required bond issues reflecting start-up, acceptance and contingency; bond financing; engineering design and construction management totals $7,233,000 for Greensboro; $3,354,000 for High Point; and $8,252,000 for Winston-Salem. Per-ton debt service of $2.50 (Greensboro); $4.20 (High Point); and $4.00 (Winston-Salem) are based upon General Obligation bond financing at six percent interest and 15-year terms.

Per ton transportation costs of $3.40 (Greensboro); $5.30 (High Point); and $3.30 (Winston-Salem) vary as a function of the quantity of RDF shipped and distance from Belew's Creek.

Net energy revenues of $6.60 per input ton of solid waste are based on 1983 coal costs of $2.24/mmBtu's or $11.29 per ton of solid waste, less an assumed O, M&R expense of $1.69 equivalent to 15 percent of gross value less a derating offset of $1.35 reflecting the fact that RDF is burned less efficiently than coal, and a debt service factor of $1.65 per ton to amortize Duke Power's capital investment of $6,240,000 to modify the Belew's Creek Facility. In projecting the revenues realized from the sale of RDF it is assumed that 56 percent of the waste generated (70 percent of the processible component) is converted to RDF and that all RDF produced is sold to Duke at equivalent fuel value less appropriate credits.

The resulting per ton disposal costs to the respective communities are $8.00 (Greensboro); $19.00 (High Point); and $10.20 (Winston-Salem). On a weighted average basis, this is equivalent to approximately $10.10 per ton.

Tables 3 through 5 summarize the economics of this technical option.

Table 3

1983 ECONOMICS FOR GREENSBORO RDF SYSTEM

SOLID WASTE THROUGHPUT (tons):		284,710
RDF PRODUCED (tons):		159,000
TOTAL CAPITAL COSTS:		$7,233,000
Equipment, including installation & modifications to existing shredder complex	$5,595,000	
Engineering Design and Construction Management (15%)	840,000	
Start-up, Acceptance and Contingency (10%)	600,000	
Bond Financing (3%)	198,000	
OPERATING COSTS:		
Debt Service	$ 703,000	
Debt Service / Ton		2.50
O, M & R	1,605,000	
O, M & R / Ton		5.60
Residual Disposal	875,000	
Residual Disposal / Ton		3.10
Transportation Costs	977,000	
Transportation Costs / Ton		3.40
LESS: RDF REVENUES		
Total Revenues	<1,880,000 >	
Revenues / Ton		< 6.60 >
NET DISPOSAL COSTS		
Disposal Costs	2,280,000	
Disposal Costs / Ton		8.00

Note: Per-ton cost and revenue elements are on a dollar basis. All other

Table 4

1983 ECONOMICS FOR HIGH POINT RDF SYSTEM

SOLID WASTE THROUGHPUT (tons):		78,070
RDF PRODUCED (tons):		44,000
TOTAL CAPITAL COSTS:		$3,354,000
Equipment, including installation & modifications to existing facility	$2,590,000	
Engineering Design and Construction Management (15%)	389,000	
Start-up, Acceptance and Contingency (10%)	282,000	
Bond Financing (3%)	93,000	
OPERATING COSTS:		
Debt Service	326,000	
Debt Service / Ton		4.20
O, M & R	874,000	
O, M & R / Ton		11.20
Residual Disposal	382,000	
Residual Disposal / Ton		4.90
Transportation Costs	414,000	
Transportation Costs / Ton		5.30
LESS: RDF REVENUES		
Total Revenues	< 516,000 >	
Revenues / Ton		< 6.60 >
NET DISPOSAL COSTS		
Disposal Costs	1,480,000	
Disposal Costs / Ton		19.00

Note: Per-ton cost and revenue elements are on a dollar basis. All other

Table 5

1983 ECONOMICS FOR WINSTON-SALEM RDF SYSTEM

SOLID WASTE THROUGHPUT (tons):		202,960
RDF PRODUCED (tons):		113,700
TOTAL CAPITAL COSTS:		8,252,000
Equipment, including installation & erection of buildings	$6,384,000	
Engineering Design and Construction Management (15%)	958,000	
Start-up, Acceptance and Contingency (10%)	684,000	
Bond Financing (3%)	226,000	
OPERATING COSTS:		
Debt Service	802,000	
Debt Service / Ton		4.00
O, M & R	1,605,000	
O, M & R / Ton		7.90
Residual Disposal	530,000	
Residual Disposal / Ton		2.60
Transportation Costs	668,000	
Transportation Costs / Ton		3.30
LESS: RDF REVENUES		
Total Revenues	<1,340,000>	
Revenues / Ton		<6.60>
NET DISPOSAL COSTS		
Disposal Costs	2,265,000	
Disposal Costs / Ton		11.20

Note: Per-ton cost and revenue elements are on a dollar basis. All other

Advantages and Disadvantages

Two major advantages to the decentralized RDF concept are that it offers a regional solution to the area's solid waste management problems, and builds upon the existing and envisioned disposal systems of High Point and Greensboro.

Several significant disadvantages, however, result from this resource recovery option. First, there are significant pricing issues which must be resolved first, if RDF is to be a reference against the cost of coal used at Belew's Creek. Because Belews Creek is supplied coal from a Duke Power captive mine, and because of the nation's abundance of coal resources, the projected 15 percent compounded annual escalation projected for liquid petroleum products may not be realized. As a consequence, the revenues realized from the sale of RDF, the value of which is tied to the price of coal, could be less than projected. To the extent that the precise impact of utilizing RDF in its modified utility boilers can only be estimated, Duke Power is likely to demand efficiency and O,M&R offsets sufficiently high to compensate it for any loss in system efficiency attributed to the use of RDF, as well as any incremental additional costs in operation, maintaining or repairing the system. It is also possible that Duke will incur additional administrative expenses and thus seek still further deducts from equivalent fuel value.

Issues of economic dispatch also must be addressed within the pricing formula. Under economic dispatch, the utility is mandated to employ its most efficient (least cost) facilities first in meeting system demand. To the extent that its nuclear facilities are initially deployed, there could be periods of time when the RDF-fired boilers would not be operational and thus, the possibility that portions of the RDf produced would be unsold.

Because of differences in the quantities of RDF processed and distances from Belew's Creek, there is a wide variation in the resultant net disposal costs to each community, ranging from $8.00 for Greensboro to $19.00 for High Point. A decentralized RDF system without High Point's participation would reduce the projected

1983 weighted average cost of disposal from $10.70 per ton to about $9.40 for Greensboro and Winston-Salem. However, the approximately 1015 TPD_6 of RDF produced by all three communities would drop to about 875 TPD_6, a quantity somewhat less than the minimum of 1000 TPD_7 initially indicated by Duke Power to be economically viable for it to purchase RDF for use at Belew's Creek.

The significant distance from Belew's Creek and the substantial quantities of RDF to be transported will require tremendous quantities of increasingly expensive and less available diesel fuel.

Finally, while the decentralized RDF System converts the solid waste into a useful product, there results from this process rejects and residuals approximating nearly 44 percent of the waste stream which will require landfill disposal.

Recommendations

Because of the significant uncertainties in the pricing of the RDF product, the substantial variance in costs between participating communities, the necessary consumption of tremendous quantities of expensive and increasingly less available diesel fuel for transporting the RDF, and the remaining waste still requiring landfill disposal, it is recommended that the communities of Greensboro, High Point and Winston-Salem not consider further this resource recovery option.

GREENSBORO 625 TPD_7 WATERWALL COMBUSTION SYSTEM WITH STEAM PRODUCED FOR SALE TO LORILLARD AND A & T UNIVERSITY

The 625 TPD_7 waterwall combustion system envisioned would produce steam for sale to Lorillard and A & T University. A potential location for the facility is the site of the former Reynolds curing facility, now a warehouse on East Market Street directly across from the Lorillard complex. A steam line of approximately 6,000 feet to connect both Lorillard and A & T University with the resource recovery system is necessary. The 625 TPD_7 waterwall combustion system consists of two 375 (approximate) waterwall boilers with electrostatic precipitators. The system is sized to accept an average of 625 TPD_7 which represents the combustible portion of the Greensboro waste stream, and up to 750 TPD_7 on a peak basis. With allowance for a 30-day scheduled shutdown for each boiler, the system has an overall operating availability of approximately 83 percent.

Municipal solid waste with an assumed HHV of 4500 Btu per pound is combusted to produce steam at 250 psig, 396 F. The system has an overall efficiency of 68 percent and produces approximately 130,000 pounds of steam per hour.

Steam produced by this resource recovery option would be purchased by Lorillard as the primary customer with A & T University purchasing steam on an as-available basis.

Economics

Estimated 1983 equipment capital costs are $44,700,000. The total size of the bond issue is $55,860,000 and reflects start-up; acceptance and contingency; bond financing; engineering and legal consulting; and debt reserve and capitalized interest. The total capital requirements include the cost for the steam line necessary to connect the sytem to both Lorillard and A & T University.

Debt service of $3,309,000 equivalent to $11.60 per available solid waste input ton, is based upon tax exempt industrial revenue bond financing at 7 percent interest with 25-year terms.

A private sector equity investment of 30 percent of the aggregate capital cost, by the system vendor and/or energy purchaser, is assumed.

Energy revenues of $5,649,000 or $19.80 per solid waste input ton is based upon the sale of steam to Lorillard at the rate of $6.21 per 1000 pounds and the sale of steam at A & T University at the rate of $5.96 per 1000 pounds, these figures representing the estimated fuel cost element of each customer in producing its own steam.

It is assumed that Lorillard, as the primary customer, would purchase on average 100,000 pounds of steam per hour, 24 hours per day, 260 days per year, for a total of 624,000,000 pounds of steam per year. A & T University would purchase approximately 297,000,000 pounds of steam on an as-available basis. Approximately 79 percent of the steam produced would be sold.

Projected net disposal costs including allowance for landfilling unprocessibles (20 percent) and residuals after combustion approximate $7.60 per ton. Without an equity participation of 30 percent, the debt service component would increase nearly $5.00, increasing the net disposal costs to $12.60 per ton.

Table 6 which follows presents the economics of this option.

Advantages and Disadvantages

Three major advantages to this system include a projected 1983 net disposal fee of $7.60 per ton; a figure competitive with the estimated $8.50 per ton cost of shredding and continued landfilling; a system capable of combusting 100 percent of the available and processible component; and the potential availability of a contiguous and appropriate site.

Four disadvantages have been identified. First could be the task of converting the preliminary and cautious interest expressed by Lorillard in the concept of purchasing steam from a resource recovery facility into a commitment. In conversations with other cigarette manufacturers (and food processors) in the course of

Table 6

1983 ECONOMICS FOR GREENSBORO 625 TPD, WATERWALL COMBUSTION SYSTEM

WITH STEAM PRODUCED FOR SALE TO LORILLARD AND A & T UNIVERSITY

ANNUAL SOLID WASTE THROUGHPUT (tons):		284,710
ANNUAL ENERGY PRODUCTION:		
Steam (pounds)		1,162,000,000
Electricity (kwh)		---
TOTAL CAPITAL COSTS:		55,086
Equipment (includes steam line)	44,070	
Start-up, Acceptance and Contingency (10%)	4,428	
Bond Financing (3%)	1,651	
Engineering and Legal Consulting	210	
Debt Reserve and Capitalized Interest	4,727	
OPERATING COSTS:		
Debt Service	3,309	
Debt Service/Ton		11.60
O, M & R	2,733	
O, M & R / Ton		9.60
Residual Disposal	1,777	
Residual Disposal / Ton		6.20
Transportation Costs	---	
Transportation Costs/Ton		---
LESS: ENERGY REVENUES		
Total Revenues	<5,649>	
Revenues/Ton		<19.80>
NET DISPOSAL COSTS:		
Disposal Costs	2,169	
Disposal Costs/Ton		7.60

Note: Per-ton cost and revenue elements are on a [illegible] basis. All [illegible]

this and other resource recovery feasibility studies, it became apparent that some corporate decision makers are concerned that their customers may perceive the purchase of energy from a resource recovery system as "making cigarettes from trash."

A & T University's wide seasonal variation in steam requirements and Lorillard's hourly variation in steam demand could present difficulties in matching energy production to energy requirements.

To connect A & T University with the envisioned system requires a major steam line of about 6000 feet, the cost of which significantly increases the system's capital costs; the placement of the steam line could present difficulties.

The location of a resource recovery system within the city proper could present adverse traffic impacts resulting from the truck delivery of up to 750 tons per day (on a peak basis) of solid waste and the removal of 150 tons of residuals.

Recommendations

While there appear to be potential obstacles to the implementation of this resource recovery option, it appears economically viable and technically feasible. As a consequence, it is recommended that Greensboro pursue further this resource recovery alternative.

Because a dedicated boiler technology also appears technically feasible to meet the combined steam needs of Lorillard and A & T University, could utilize Greensboro's shredder complex and is likely to be cost competitive with the waterwall combustion option, a more detailed evaluation of both approaches is also recommended.

GREENSBORO 625 TPD_7 WATERWALL COMBUSTION SYSTEM WITH STEAM AND ELECTRICITY PRODUCED FOR SALE TO LORILLARD

This system consists of two 375 TPD (approximate) waterwall boilers with electrostatic precipitators and electric turbo generating equipment. This system is also sized to accept on average 625 TPD_7 of Greensboro combustible waste and up to 750 TPD_7 on a peak basis. A potential site for this facility exists at the site of the former Reynolds curing complex opposite Lorillard on East Market Street. This system has an 83 percent overall operating availability with allowance for a 30 day scheduled shutdown for each boiler. System thermal efficiency is 68 percent.

Steam is produced at 600 psig, 700 F. The system produces approximately 118,000 pounds of steam per hour, 24 hours a day and 365 days a year of which 100,000 pounds per hour, 24 hours per day and 260 days per year is extracted at 150 psig for sale to Lorillard Company.

Steam, when extracted at 150 psig, is converted to electricity at the rate of one KWH per 50 pounds of steam. The remaining steam at 600 pisg, 700 F. is directed through a condensing turbine generator and is converted to electricity at the rate of one KWH per 10 pounds of steam. Annual steam sales are approximately 624,000,000 pounds. Annual electricity production is approximately 55,920,000 KWH.

Economics

Estimated 1983 capital cost for this particular system is $50,424,000. Start-up, acceptance, and contingency; bond financing; engineering and legal consulting; and debt reserve and capitalized interest bring the total bond issue to $62,906,000.

Debt service of $3,779,000 equivalent to $13.30 per available input solid waste ton is based upon 7-percent industrial revenue bond tax exempt financing at 25-year terms. An equity investment of 30 percent of the aggregate capital by the system vendor and/or energy customer is made to minimize debt service expenses.

Steam and electricity revenues are $5,611,000, representing approximately $19.70 per input ton. Energy revenues are predicated

upon Lorillard's 1983 projected fuel costs of 66¢ per gallon and fuel component steam costs of $6.21 per 1000 pounds. Electricity revenues are projected at a retail price of 43.7 mils per KWH on a retail basis and 21.9 mils per KWH on a wholesale basis: 12,480,000 KWH of the electricity produced is sold to Lorillard at retail. The remainder (43,440,000 KWH) is sold at wholesale.

Projected net disposal costs are $10.20 per ton and include the cost of landfilling unprocessibles and combustion residuals. The resulting net disposal cost in the event that 30 percent private sector equity participation is not made is $15.90, an increase of nearly $6.00 per ton.

Table 7 summarizes the economics of this alternative.

Advantages and Disadvantages

Four principal advantages to this system are that the system: combusts all of the processible waste generated by the city of Greensboro; offers flexibility in meeting the energy requirements of the customer without "dumping" energy; appears to have an available contiguous and suitable site; and eliminates the requirement of a major steam line (to connect A & T University).

However, there are four disadvantages to this system, as well. First, while the concept of cogenerating steam and electricity from the combustion of solid waste is viable, there remain technical uncertainties to this approach, particularly at the scale envisioned. Turbine generators are most efficient with a constant steam input yet there would be variation in steam available to the turbine generator resulting from fluctuations in Lorillard's process steam requirements.

Second, cogeneration requires high quality water, necessitating sophisticated water treatment equipment. As well, the flexibility offered by a cogenerating system has its cost; because of the additional equipment required and since it must be designed and constructed especially for the customer, capital costs as well as O, M&R expenses are typically greater.

Third, there still remains the issue of Lorillard actually committing to the purchase of energy produced from a resource recovery system in light of the concerns expressed that some of its customers may react adversely to this concept.

Fourth, as with the other steam-producing resource recovery options producing energy for sale to Lorillard, there could be significant traffic impacts from both the delivery of solid waste and removal of residuals.

Recommendations

This system was evaluated because of Lorillard's expressed interest in the concept of cogernation. While the concept still remains technically viable, it results in less favorable economics than the previous option and is technically more uncertain. For these reasons, it is recommended that this option be pursued further only in the event that the other more promising resource recovery options appear confronted by insurmountable obstacles.

GREENSBORO 470 TPD_6 WATERWALL COMBUSTION SYSTEM WITH STEAM PRODUCED FOR SALE TO CONE

The system consists of two 285 TPD boilers with electrostatic precipitators. The system is sized to accept an average 471 TPD on a 6-day basis, and to meet the projected steam requirement for Cone at its Greensboro complex. A potential site exists for this resource recovery facility within the Cone complex.

With an allowance for a 30-day scheduled shutdown for each boiler, the system has overall operating availability of approximately 83 percent. Steam at 250 psig and 396 F is produced at the rate of 100,000 pounds per hour. This is based on an assumed HHV of 4500 Btu per pound of solid waste and rated system thermal efficiency of 68 percent.

Economics

The 1983 estimated equipment capital cost for this particular resource recovery system is $34,398,000. Start-up, acceptance and contingency; bond financing; engineering and legal consulting; and debt reserve and capitalized interest bring the total bond issue to approximately $42,987,000.

Debt service of $2,582,000 equivalent to $17.60 per input ton of solid waste is based upon 7 percent tax exempt industrial revenue bond financing at 25-year terms. A 30 percent private sector equity investment is assumed.

Energy revenues of $3,399,000 or $23.10 per input ton bring the net disposal cost to $1,828,000 or approximately $12.50 per input ton. Steam sales of approximately 749,455,000 pounds represent 88 percent of the available steam produced.

Because of its location contiguous to a residential area, it is assumed that approximately 20 percent of the waste can be delivered directly be refuse trucks. The remaining 80 percent of the waste would be delivered by transfer trailer. This would contribute an additional $2.00 per ton to the net disposal cost.

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The net disposal costs are projected at $12.50 per ton. Without a private sector equity investment the net disposal costs would increase by about $7.50 per ton to $20.00

Table 8 presents an economic summary of this option.

Advantages and Disadvantages

A preliminary investigation indicates that there are several potential sites for a resource recovery system serving Cone within the Cone complex. Because this land is contiguous to the operation acreage and appears to offer no topographical impediments, it is likely that a site can be secured.

Several disadvantages of this prospective resource recovery option are obvious. First, in light of recent production cutbacks and consolidations at the Cone complex the question of Cone's continued commitment to operating at the Greensboro area must be ascertained. Second, the system as proposed would be capable of disposing only 65 percent of the available unprocessible waste, requiring other disposal methods.

This system also projects considerably higher net disposal costs ($12.50) than the options of continued landfilling and two other resource recovery systems. Finally, although located within an industrial area, the Cone complex is surrounded by a residential area. To minimize the impacts of solid waste deliveries and residual, removal may necessitate the consolidation of the solid waste currently collected by refuse packer into tractor trailers for delivery to the resource recovery site. This additional trucking increases the costs of disposal by approximately $2.00 per ton.

Recommendations

The extent of Cone's interest in the concept of purchasing energy from a contiguous resource recovery facility, including its commitment to the Greensboro complex, should first be established. If Cone's interest proceeds past the preliminary and cautious stage, this option could be considered as an alternative

Table 8

1983 ECONOMICS FOR GREENSBORO 470 TPD$_6$ WATERWALL COMBUSTION SYSTEM
WITH STEAM PRODUCED FOR SALE TO CONE

ANNUAL SOLID WASTE THROUGHPUT (tons):		146,952
ANNUAL ENERGY PRODUCTION:		
Steam (pounds)		749,455,000
Electricity (kwh)		--
TOTAL CAPITAL COSTS:		$42,987
Equipment	34,398	
Start-up, Acceptance and Contingency (10%)	3,440	
Bond Financing (3%)	1,251	
Engineering and Legal Consulting	210	
Debt Reserve and Capitalized Interest	3,688	
OPERATING COSTS:		
Debt Service	2,582	
Debt Service/Ton		17.60
O, M & R	1,763	
O, M & R / Ton		12.00
Residual Disposal	588	
Residual Disposal / Ton		4.00
Transportation Costs	294	
Transportation Costs / Ton		2.00
LESS: ENERGY REVENUES		
Total Revenues	< 3,399 >	
Revenues / Ton		< 23.10 >
NET DISPOSAL COSTS:		
Disposal Costs	1,828	
Disposal Costs / Ton		12.50

A dedicated boiler technology also appears technically feasible to meet the steam requirements of Cone. Moreover, such an approach could utilize Greensboro's shredder complex and is likely to be cost competitive with the envisioned waterwall combustion option. For these reasons a more detailed evaluation of both technologies is warranted.

GREENSBORO 625 TPD_7 WATERWALL COMBUSTION SYSTEM WITH STEAM AND ELECTRICITY PRODUCED FOR SALE TO CONE

The 625 TPD_7 waterwall combustion system with steam and electricity produced for sale to Cone would consist of two 375 TPD (approximately) waterwall boilers with electrostatic precipitators and turbine generating equipment. A potential site exists for the facility within the Cone complex. The system is sized to accept an average of 625 TPD_7 which represents the combustible portion of the Greensboro wastestream, and up to 750 TPD on a peak basis. With an allowance for a 30-day scheduled shutdown for each boiler, the system has an operating factor of approximately 83 percent. The overall thermal efficiency of the system is 68 percent.

Municipal solid waste with an assumed HHV of 4500 Btu per pound is combusted to produce approximately 117,600 pounds of steam per hour at 600 psig, 700 F., of which 80,000 pounds per hour is extracted at 150 psig for sale to Cone. One KWH of electricity is produced per 50 pounds of steam extracted at 150 psig, or 10 pounds of steam that enters the generator at 600 psig and is then condensed. Approximately 10 percent of the electricity produced is utilized internally.

Economics

Estimated 1983 equipment costs approximate $50,424,000. Start-up, acceptance and contingency; bond financing; engineering and legal consulting; and debt reserve and capitalized interest bring the total bond issue to $62,906,000.

Debt service of $3,779,000 is equivalent to $13.30 per input ton of solid waste based on tax exempt industrial bond financing at 7 percent interest and 25-year terms. A private sector equity investment of 30 percent of gross capital costs is assumed.

Transportation costs arising from the consolidation of waste collected by refuse packer, automobile and pickup trucks, into tractor tractor trailers necessary to mitigate traffic impacts total $569,000 or $2.00 per ton.

Energy revenues of approximately $4,533,000 equivalent to $16.00 per input ton are realized on the sale of steam and electricity to Cone. It is assumed that 499,200,000 pounds of steam extracted at 150 psig are sold to Cone, at the rate of 80,000 pounds per hour, 24 hours per day, and 260 days per year. Approximately 28,080,000 KWH of electricity are sold at retail at 43.7 mils, and the remaining 34,486,000 KWH are sold at wholesale at a price of 21.9 mils per KWH.

Net disposal costs are projected at $15.90 per ton under this resource recovery option. Without a private sector 30 percent equity investment, debt service expenses are increased by $5.70 per ton, resulting in a net disposal cost of $21.60.

Table 9 which follows presents the economics of this alternative.

Advantages and Disadvantages

The apparent availability of a suitable contiguous site could serve to accelerate the implementation process for a resource recovery facility serving Cone. The proposed system could accept 100 percent of the processible waste available from Greensboro; the production of both steam and electricity could give added flexibility to resource recovery as energy production can be more closely matched with the customer's energy requirements.

However, there are several significant disadvantages to the envisioned steam and electricity producing system. First, while the concept of producing both steam and electricity (cogeneration) is viable, there remain technical uncertainties to this approach, particularly at this scale. Turbine generators are most efficient with a constant steam input. The variability in steam inputs to the turbine generator resulting from changes in process steam requirements could present operational difficulties. Cogeneration requires high quality water, necessitating sophisticated water treatment equipment. As well, the flexibility offered by a cogenerating system has its cost; since it must be designed and

Table 9

1983 ECONOMICS FOR GREENSBORO 625 TPD, WATERWALL COMBUSTION SYSTEM WITH STEAM AND ELECTRICITY PRODUCED FOR SALE TO CONE

ANNUAL SOLID WASTE THROUGHPUT (tons):		284,710
ANNUAL ENERGY PRODUCTION:		
Steam (pounds)		499,000,000
Electricity (kwh)		62,566,000
TOTAL CAPITAL COSTS:		62,906
Equipment	50,424	
Start-up, Acceptance and Contingency (10%)	5,042	
Bond Financing (3%)	1,832	
Engineering and Legal Consulting	210	
Debt Reserve and Capitalized Interest	5,398	
OPERATING COSTS:		
Debt Service	3,779	
Debt Service/Ton		13.30
O, M & R	2,961	
O, M & R / Ton		10.40
Residual Disposal	1,777	
Residual Disposal / Ton		6.20
Transportation Costs	569	
Transportation Costs / Ton		2.00
LESS: ENERGY REVENUES		
Total Revenues	< 4,553 >	
Revenues / Ton		< 16.00 >
NET DISPOSAL COSTS:		
Disposal Costs	4,533	
Disposal Costs / Ton		15.90

Note: Per ton cost [illegible]

constructed especially for the customer, there are increased capital costs and operation, maintenance and replacement expenses.

Further issues requiring resolution are Cone's commitment to continued operation of this facility, the substantial projected net disposal costs of this resource recovery option and possible significant adverse traffic impacts.

Recommendations

Because of the technical uncertainties attendant with the cogeneration of steam and electricity from a resource recovery system at this scale, and the significantly higher net disposal costs resulting from this option, it is recommended that this option be pursued only in the event that other more promising options falter.

HIGH POINT 90 TPD_6 MODULAR COMBUSTION SYSTEM WITH STEAM PRODUCED FOR SALE TO J.P. STEVENS (WEST AVENUE)

The 90 TPD_6 modular combustion system is comprised of four 25 TPD modular combustion units. The system is envisioned to operate 6 days a week, 50 weeks per year, for a total of 300 days per year. Effective capacity is 90 percent, based on a 90-percent availability factor. Approximately 27,000 tons per year of processible solid waste can be disposed of utilizing this resource recovery option.

The system has overall operating efficiency of 65 percent, and produces approximately 18,400 pounds of 150 psig steam per hour. It is assumed that MSW has a Btu content of 4500 per pound.

Economics

Total capital cost in 1983 for the modular combustion system with steam production is approximately $3,900,000. Start-up, acceptance and contingency; bond financing; engineering and legal consulting; and debt reserve and capitalized interest bring the total bond issue to $5,064,000.

Debt service of $335,000, or $12.30 per input solid waste ton, is based upon 7-percent, 20-year term financing with tax exempt industrial revenue bonds. A private sector equity investment of 30 percent of aggregate cost is assumed.

Energy revenues of $710,000 or $26.30 per input ton, bring the net disposal cost of $111,000, or approximately $4.10 per solid waste input ton. Revenues are predicated upon a 1983 projected fuel component steam cost of $6.33/1000 pounds and fuel costs of $.65 per gallon.

Projected net disposal costs under this resource recovery alternative are $4.10 per ton. Without an equity investment, debt service expenses would increase by nearly $5.30, raising the net disposal costs to $9.40 per ton.

Table 10 summarizes the economics of this option.

Table 10

1983 ECONOMICS FOR HIGH POINT 90 TPD_6 MODULAR COMBUSTION SYSTEM
WITH STEAM PRODUCED FOR SALE TO J.P. STEVENS

ANNUAL SOLID WASTE THROUGHPUT (TONS):		27,000
ANNUAL ENERGY PRODUCTION:		
Steam (pounds)		132,300,000
Electricity (kwh)		--
TOTAL CAPITAL COSTS:		5,064
Equipment	3,900	
Start-up, Acceptance and Contingency (10%)	390	
Bond Financing (3%)	147	
Engineering and Legal Consulting	150	
Debt Reserve and Capitalized Interest	478	
OPERATING COSTS:		
Debt Service		
Debt Service/Ton	335	
O, M & R		12.30
O, M & R / Ton	378	
Residual Disposal		14.00
Residual Disposal / Ton	108	
Transportation Costs		4.00
Transportation Costs / Ton	--	
LESS: ENERGY REVENUES		--
Total Revenues	< 710 >	
Revenues / Ton		< 26.30 >
NET DISPOSAL COSTS:		
Disposal Costs	111	
Disposal Costs / Ton		4.10

Note: Per-ton cost and revenue elements are on a [illegible]

Advantages and Disadvantages

The envisioned 90 TPD_6 modular combustion system has two significant advantages. Its projected 1983 net disposal costs of approximately $4.00 per ton is competitive with the alternative of continued shredding and landfilling (at 12.00 per ton); and the system could be implemented and operational within three years of project commitment. As well, because J.P. Stevens has expressed interest in investing in a new coal-fired power plant for this facility in response to dramatic liquid fuel oil increases and possible future shortfalls, it may be willing to invest in a resource recovery facility as an alternative to coal-fired equipment.

However, there are three major disadvantages. First, there appears to be significant siting problems. The J.P. Stevens facility is located in a congested industrial park on West Avenue, where limited space is available. Second, it may be necessary to get additional firms to commit to the purchase of steam on an as-available basis to ensure economic viability. Another disadvantage to this system is that it can combust only 90 TPD_6 of the 200 TPD_6 generated by the City of High Point. As a consequence, continued shredding and landfilling will be necessary to dispose of the remaining solid waste (unless other resource recovery options can be found). While possible savings in disposal costs and extension of landfill life will occur, the costs of resource recovery will be largely incremental to existing costs.

Recommendation

It is recommended that this resource recovery option be pursued further to determine if a site can be developed within the West Avenue Complex, and to ascertain the willingness of J.P. Stevens to commit itself to purchasing energy from this system, particularly since it is considering installing a coal-fired boiler to reduce energy costs and dependence on oil.

WINSTON-SALEM 250 TPD_6 MODULAR COMBUSTION SYSTEM WITH STEAM TO HANES

This system could be located at the site of one of the existing Winston-Salem landfill facilities, contiguous to the Hanes facility (Weeks plant off Route 52). The 250 TPD_6 modular combustion system consists of six 55-TPD modules. It is envisioned that five of these modules would be operated 5 days per week, 260 days per year, 24 hours per day, with the sixth held as an alternative or backup module. The entire system has a 76-percent availability factor, allowing it to process 90 TPD, 312 days per year. Steam produced from this system would be sold to Hanes, whose typical steam requirements are 24 hours per day, 5 to 6 days per week.

The system has a rated thermal efficiency of 65 percent and produces approximately 51,000 pounds per hour of 150 psig steam. Annual steam production is 318,240,000 pounds, of which approximately 88 percent is sold to Hanes based on the assumption that Hanes will require steam 275 (equivalent) days per year.

Economics

Capital equipment costs for this system are approximately $7,566,000 in 1983. Start-up, acceptance and contingency; bond financing; engineering and legal consulting; and debt reserve and capitalized interest bring the total capital requirements to $9,768,000.

Debt service totaling $625,000, or $9.90 per input ton, is predicated upon 7-percent tax-exempt industrial revenue bond financing with 20-year terms and an equity investment of 30 percent.

Energy revenues of $1,424,000, equivalent to $21.90 per input ton, are predicated upon a 1983 projected cost of fuel of $.54 per gallon, with a corresponding fuel component of steam of $5.07 per 1000 pounds of steam.

The resultant net disposal cost is $4.60 per input solid waste ton. Without the equity investment the net disposal cost would be increased by approximately $4.20 to $8.80 per ton.

Table 11 which follows summarizes the economics of this system.

Table 11

1983 ECONOMICS FOR WINSTON-SALEM 250 TPD_S MODULAR COMBUSTION SYSTEM WITH STEAM PRODUCED FOR SALE TO HANES CORPORATION

ANNUAL SOLID WASTE THROUGHPUT (tons):		65,000
ANNUAL ENERGY PRODUCTION:		
Steam (pounds)		318,240,000
Electricity (kwh)		--
TOTAL CAPITAL COSTS:		9,768
Equipment	7,566	
Start-up, Acceptance and Contingency (10%)	757	
Bond Financing (3%)	313	
Engineering and Legal Consulting	210	
Debt Reserve and Capitalized Interest	922	
OPERATING COSTS:		
Debt Service	645	
Debt Service/Ton		9.90
O, M & R	819	
O, M & R / Ton		12.60
Residual Disposal	260	
Residual Disposal / Ton		4.00
Transportation Costs	--	
Transportation Costs / Ton		--
LESS: ENERGY REVENUES		
Total Revenues	1,424	
Revenues / Ton		< 21.90 >
NET DISPOSAL COSTS:		
Disposal Costs	301	
Disposal Costs / Ton		4.60

Note: Per-ton cost and revenue elements

Advantages and Disadvantages

There are four significant advantages to the proposed system. New disposal costs are projected at about $4.60 per ton, a figure competitive with the estimated costs of continued landfilling ($6.50). While some of the costs attendant with this resource recovery option would be incremental and thus in addition to the costs of continued landfilling, there are opportunities to achieve significant disposal savings. The quantity of waste currently delivered to the Route 52 landfill, which is contiguous to the prospective energy customer, approximates the materials requirements of the proposed resource recovery system. This landfill could be closed and converted into a site for resource recovery, allowing for a consolidation of disposal operations with resultant savings with modest impact upon current disposal practices.

The system envisioned could be implemented and operational within three years from commitment, significantly in advance of the various large-scale resource recovery options.

One apparent disadvantage to this system is the fact that it processes only a portion of the processible solid waste.

Recommendations

Hanes' commitment to the purchase of steam from the resource recovery system must now be determined. This resource recovery option offers the most promise and should be pursued immediately and aggressively.

Table 12

ADVANTAGES AND DISADVANTAGES OF RESOURCE RECOVERY OPTIONS

Decentralized 1015 TPD_6 RDF System

Advantages

- Regional solution
- Utilizes all processible waste in two counties
- Builds upon current disposal facilities and practices
- Available sites located at existing landfills

Disadvantages

- Value of RDF per mm Btu substantially less than from steam
- Wide variation in costs to respective communities with very high net costs to High Point
- Truck transport of RDF consumes substantial quantities of expensive and less available diesel fuel
- Approximately 44 percent of available waste remains as a process reject or residual and requires ultimate landfilling
- Risk of negative price for RDF
- May require protracted negotiations with Duke Power
- All system performance risks are borne by three cities

Greensboro 625 TPD_7 Waterwall Combustion or Dedicated Boiler System with Steam to Lorillard and A&T University

Advantages

- Cost competitive projected net disposal costs
- Accepts all of Greensboro's processible waste
- Existing potential site
- Meets average hourly steam demand at Lorillard

Disadvantages

- Energy purchaser's concerns that its customer may react negatively to concept of "producing cigarettes from trash"
- Difficulty in coordinating steam product with customer's energy demand, especially at A&T University during winter
- Requires major steam line to A&T University and uncertainty that right of way can be obtained
- Potential for adverse traffic impacts
- May eliminate use of investment in

Table 12 (continued)

Greensboro 625 TPD_7 Waterwall Combustion or Dedicated Boiler System with Steam and Electricity to Lorillard

Advantages

- Accepts all of Greensboro's processible waste
- System has flexibility in matching energy production to customer's energy demand
- Existing potential site
- Meets Lorillard steam and portion of electricity demands

Disadvantages

- Technical uncertainties to the cogeneration of steam and electricity from a resource recovery system of this scale
- Energy purchaser's concerns that its customers may react negatively to concept
- Potential for adverse traffic impacts
- Value of electricity product low
- Duke Power may resist purchasing excess electricity

Greensboro 470 TPD_6 Waterwall Combustion or Dedicated Boiler System with Steam to Cone

Advantages

- Meets Cone's average hourly steam demand
- Vacant site in close proximity to Cone's boiler plant and steam line

Disadvantages

- In view of recent consolidation at its Greensboro complex, Cone's commitment to continual operations in the area must be ascertained
- System processes only ≈ 65 percent of the available processible waste
- Projected net disposal costs of $12.50 per ton are significantly higher than costs of current disposal operations
- Potential for adverse traffic impacts
- Uncertainty that site could be obtained from Cone

Table 12 (continued)

Greensboro 625 TPD_7 Waterwall Combustion or Dedicated Boiler System with Steam and Electricity to Cone

Advantages

- Accepts all of Greensboro's processible waste
- System has flexibility in matching energy production to customer's energy demand
- Existing potential sites

Disadvantages

- Technical uncertainties to the cogeneration of steam and electricity from a resource recovery system of this scale
- Projected net disposal costs of $14.60 per ton are significantly higher than costs of current disposal operations
- Cone's commitment to continued operations at the Greensboro complex must be ascertained
- Value of electricity produced low
- Duke Power may resist purchasing excess electricity
- Potential for adverse traffic impacts

High Point 90 TPD_6 Modular Combustion System with Steam to J. P. Stevens

Advantages

- Projected net disposal fee cost competitive with existing practices
- Potential customer appears committed to converting existing power plant from increasingly expensive and scarce fuel oil
- Scale and technology of system allows for reasonably speedy implementation

Disadvantages

- Significant siting difficulties must be overcome
- Because of J. P. Stevens' modest energy demands, additional customers may be required to assure economic viability
- System's capacity limits the quantity of waste which can be accepted to about 40 percent of available waste
- Possible severe traffic congestion

Table 12 (continued)

Winston-Salem 250 TPD_S Modular Combustion System with Steam to Hanes

Advantages

- Projected net disposal fee cost of $4.60/Ton competitive with existing practices
- System presents opportunities to consolidate existing facilities and effect disposal savings
- Available site located at existing landfill
- Scale and technology of system allows for a reasonably speedy implementation

Disadvantages

- System's capacity limits the quantity of waste which can be accepted to about 50 percent of available waste

CHAPTER 6

NEXT STEPS

Because the technical evaluation and economic analysis of the respective resource recovery options were preliminary in scope, there are a number of issues which must be resolved and tasks performed before a commitment to implement one or more of the systems is made.

Issues requiring resolution and tasks to be performed fall within the following seven categories:

- Waste characteristics, impacts and economics
- Energy market verification
- System definition
- Procurement methods and sponsorship form
- Financing strategies
- Risk allocations
- Legal and institutional barriers

Waste Characteristics, Impacts and Economics

While a preliminary characterization of the region's solid waste practices and composition has been done, considerable additional work must be performed. First, accurate waste composition data must be obtained to determine the actual characteristics of the waste, including quantities generated, quantities processible, and the Btu content of the processible solid waste. Second, the economic and operational impacts of resource recovery upon existing collection and disposal practices must be determined. It must be determined whether there will be incremental savings attendant with resource recovery; or whether the cost of resource recovery will be additional to existing disposal costs. Third, it must be determined whether private haulers will in fact deliver their waste to resource recovery systems or whether, because of perceived or real savings, will elect to deliver their waste to other disposal facilities. Fourth, projected traffic

impacts resulting from changes in current practices in delivery of waste to a resource recovery facility must be ascertained. As well, the optimal mode of waste delivery to a new resource recovery facility must be determined. Is it better to deliver the waste in packer trucks, or should the waste be consolidated at the existing disposal site, loaded into a transfer trailer, and delivered to the resource recovery system?

Energy Market Verification

While a preliminary market study indicated that there were six prospective customers interested in the concept of purchasing energy from a resource recovery project, this interest was both preliminary and cautious. For that reason, the level of commitment must be established for each of the prospective customers to ensure that in fact there will be an energy buyer if the project proceeds further.

Having established a commitment to purchase energy from a resource recovery project by one or more prospective customers, necessitates the formulation of the principals of a purchase arrangement between the energy buyer and the sponsor. These principals include optional ways of pricing the energy, and establishing the length of the purchase contract and negotiating a firm put-or-pay concept, as well as developing pricing escalators.

For each prospective customer, detailed energy load profiles must be developed, including seasonal energy variation, daily energy requirements, and electrical consumption.

Consideration should also be given to future industrial growth trends. The prospect of available and competitively priced energy from a resource recovery system could serve as a strong catalyst for industrial development. The possibility of attracting a new industry to the area (as an energy customer) should not be overlooked.

System Definition

The energy requirements and practices of the prospective customer, to a large extent, define the scale and technology of

the resource recovery system. Customer-specific issues such as locating a site, siting impediments and steam line requirements can affect significantly the capital costs of otherwise similar systems.

The four resource recovery options appropriate to Greensboro were predicated upon the production of steam as primary energy product from a waterwall combustion technology or a dedicated boiler concept, wherein coarsely shredded solid waste with oversized bulky materials and magnetics removed is fired in a specially designed solid fuel boiler. Because both technologies appear technologically feasible, further effort must be devoted to defining the system appropriate to serve one or more of the prospective energy customers.

Procurement and Sponsorship

The appropriate procurement strategy must be developed to ensure that both risks and costs to the participating communities are minimized. A choice must be made between an architect/engineer (A/E) or turnkey full-service approach.

Furthermore, it should be determined whether the city, the county, or a specially created authority would be the best sponsor of a particular resource recovery project.

Financing Strategies

The optimal financing strategy must be ascertained to ensure that a cost effective financing method is employed. Choices must be made between the use of tax-exempt general obligation or industrial revenue bonds, private sector equity participation or combinations thereof.

Risk Allocation

System availability, reliability and maintainability are key risk parameters attendant with any resource recovery system. Therefore, it must be determined whether prospective vendors are

prepared to offer bonding over the full life of the bond issue, as in a turnkey approach, or whether the sponsoring agency or participating communities must shoulder the majority risk of economic or technical uncertainty. Mechanisms to deal with the default of a vendor or buyer must be addressed and force majeure events such as changes in the waste composition or environmental laws must be defined.

To reduce the economic risk of resource recovery, firm put-or-pay commitments must be obtained from the waste generating communities, and take-or-pay contracts from the energy customers.

Under a put-or-pay contract the waste generating communities agree to deliver a minimum quantity of solid waste and to pay a tipping fee based on that quantity whether waste is delivered or not.

A take-or-pay contract obligates the energy customer to pay for the fuel or energy produced by a resource recovery system whether he accepts it or not.

Legal and Institutional Barriers

Numerous legal and institutional barriers to the implementation of a resource recovery project exist, primarily due to the fact that few projects have ever been implemented. Institutional and legal barriers including site acquisition issues, the implication of traffic impacts upon the surrounding neighborhoods and/or communities, the legality of negotiational procurements and long-term put-or-pay and take-or-pay contracts, the prospect of mandatory participation of private haulers all must be resolved in an appropriate and timely manner.